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OCEAN SURFACE WATER SAMPLING DEVICES.(U)

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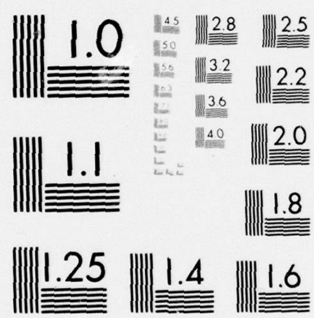

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OCEAN SURFACE WATER SAMPLING DEVICES

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SOUND DIVISION

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ABSTRACT

This report traces the development and sea tests of various devices to obtain a surface water sample. The first were 1-liter polyethylene wash bottles with intake attachments. They were squeezed to create a partial vacuum and thrown from helicopters. In practice they collected over 100 milliliters of water. Other samplers were built around 1-liter filter flasks. These samplers were evacuated and parachuted to the water, where the impact would break open intake tubes. They were effective about 75% of the time in collecting a liter of water from 6 to 8 inches below the surface. Another sampler, also parachuted, captures a volume of the water surface by a cookie cutter action and drew it into a 1-liter Thermos bottle for protection from temperature change and sunlight. Filter paper bands gave way on becoming wet and released spring clips on rubber intake tubes. These samplers were only 60% effective in landing upright on the water. Faster Dewar samplers without the cookie cutter action but with the same intake method proved about 95% effective in collecting their combined capacity. A more elaborate sampler, having an electric timer mechanism to open spring clips and manually placed on the water, proved only about 60% effective because of unreliability of the mechanism. For larger volumes of water, a 5-gallon polyethylene carboy with a wooden board float on its neck to maintain the necessary filling orientation proved 98% effective.

PROBLEM STATUS

This is an interim report on the problem; work on the problem is continuing.

AUTHORIZATION

NRL Problem S01-18
Project SF 001-03-13-8136

OCEAN SURFACE WATER SAMPLING DEVICES

INTRODUCTION

In order to study the physical and chemical properties of the ocean near the surface, a suitable device must be used to obtain a sample of the surface water. Surface samplers have been developed that will collect desired amounts of surface water and that meet the following requirements: they should be inexpensive , be cleanable by ordinary chemical practices*, be chemically inert to sea water, be rugged enough to withstand dropping from an airplane, be light enough to make a water entry with minimum disturbance to the surface of the water and be able to collect from 1/10 to 20 liters of water. Although these devices would be picked up by a boat, they were generally designed to be dropped from the air since a boat would disturb the surface. This report traces the evolution of our present samplers and presents the results of tests in the open ocean.

THE POLYETHYLENE SAMPLER

A 1-liter polyethylene wash bottle was the first sampler tried. Polyethylene is known to be chemically inert to sea water, and can be cleaned by ordinary chemical methods. The flexibility of the walls of this lightweight, unbreakable bottle was one of the deciding factors that led to its use as a sampler. The bottle could be dropped from an airplane without breaking. A partial vacuum could be created inside the bottle by merely squeezing it. To utilize the polyethylene wash bottle as a surface sampler, it was necessary to know the amount of time needed to compress the bottle and restore it to its original shape, also the amount of water collected during restoration time, and the amount of water collected after partial restoration time in the air. Table 1 shows the data giving this information.

*See, for example, F. Rosebury, "Tube Laboratory Manual", 2nd ed. , Research Laboratory of Electronics, M. I. T. , Cambridge, Mass. , 1956.

Figure 1 illustrates the modified wash bottle that was used to collect surface water on the first open ocean experiment. In practice, the polyethylene sampler was found to work quite well. It collected over 100 milliliters of water from a depth very close to the water surface. The only difficulty encountered was deploying a cluster of the bottles from a helicopter. The light weight of the bottles made it very difficult to throw them out of the side door of a helicopter with a fast moving down draft.

FILTERING FLASK TYPE SAMPLERS

Design A

Figure 2 is an example of the next sampler developed. This sampler made use of the capabilities of a 1-liter filtering flask which was the capacity desired at this time. The flask was made of thick glass which could easily be cleaned chemically, but which was not too heavy. The flask was surrounded with Styrofoam for buoyancy. Design A has an impact type trigger consisting of thin-wall, small-diameter glass tubing that would break upon impact with the water after being thrown from an airplane. A parachute was used with this sampler to insure a light impact with the water that would still be hard enough to activate the trigger. This sampler, like the polyethylene bottle, depended upon a vacuum inside the sampler to draw in the desired sample of water. The flapper valve shown in Fig. 2 was used to keep the sample water from escaping while the sampler was being lifted from the ocean.

Design B

The design of Fig. 3 gave much more stability in rough seas due to the design of a lower center of buoyancy. The same type of 1-liter filter flask was used but inverted in the sytrofoam buoy. A hole was made in the bottom of the flask and a rubber stopper adapted with a long glass tube running through the stopper to within an inch of the top of the flask. This design eliminated the flapper valve of design A.

The trigger of design B consisted of a microscope slide that was held to the intake hole by evacuating the air from inside the flask. The sampler was dropped from an airplane

by parachute and upon impact with the water surface the slide would break loose and allow a sample of water to be drawn into the flask.

Both types A and B worked reasonably well in the open ocean. They were stable during flight with a parachute. A liter of water from 6 to 8 inches below the surface was collected during operations, and the triggers proved to be about 75% effective. The effectiveness of all samplers in this report was calculated by dividing the total amount of collected water by the combined capacity of all the bottles dropped.

THE COOKIE-CUTTER SAMPLER

The cookie-cutter sampler shown in Figs. 4-6 was designed to provide two new capabilities sought in a sampler. It was desired to isolate the water sample from the sunlight and a gross temperature change after the sample had been taken. It was also desired to capture an area of the water surface before the triggering action started.

In place of the filter flasks of the previous sampler, a Thermos bottle was used. The Thermos bottle isolated the water sample from temperature changed and direct sunlight. To capture an area of water surface a cookie-cutter type edge was made of Plexiglas and was fabricated around the buoy. This edge, first to enter the water, was intended to keep the surface of the water from flowing out from under the buoy when the sampler came in contact with the ocean surface.

The triggering action was quite different on this sampler from that of any other prior sampler. Special spring clips were used to pinch the rubber tubing at the intake of the Thermos bottle. The clips were held in this pinching position by wrapping chemical filter paper No. 40 around the open end. Filter paper has strength when dry but falls apart when wet and under tension. The length of time for the trigger to be activated after contact with the water was a fraction of a second.

The cookie-cutter sampler was an airborne sampler and descended by parachute. The capacity of the sampler was 1 liter of sample water.

Tests in the Chesapeake Bay proved that the cookie-cutter worked partially according to the design plan. The sampler was dropped from an airplane. During the drop time the sampler was observed to be unstable in very windy weather. This instability caused the sampler to land on the water surface in an inverted position at times. Because of this windy weather characteristic, the sampler proved to be about 60% effective.

THE DEWAR SAMPLER

The Dewar sampler (Fig. 7) was designed as a fast-descending sampler with rapid intake. The fast descent was achieved by using a small drag chute in place of the parachute. The drag chute was opened by a static line from the airplane. The sampler was designed with the least number of protruding parts to keep from slowing it down while descending to the water surface. Rapid intake was achieved by placing a spring clip trigger, developed with the cookie-cutter sampler, on the part of the intake hose first to enter the water.

The Dewar sampler had a capacity of about 1 liter. It proved to be a strongly built bottle, able to resist breakage when hitting the water from a low flying airplane. A buoy on the closed end of the bottle prevented the bottle from sinking after the water sample had taken the place of the vacuum inside of the bottle.

Two depths of samples were taken with the Dewar sampler, one from the immediate surface of the water using the intake design at the left in Fig. 7, and the other from 6 to 8 inches below the water surface, using the intake design at the right in Fig. 7.

The Dewar sampler was tested and found to meet design requirements. The sampler was found to be about 95% effective. This type of sampler was used on five field trips and the sampler's performance on these trips was uniformly excellent.

THE TIMER BUOY SAMPLER

Figure 8 shows the design of a pretimed sampler. Two vacuum bottles were used on this sampler. One collected a sample from the water surface and the other from about a foot below. This sampler was designed to meet specific characteristics desired at the particular time. One difference of this sampler from the ones previously described was that it was not an airborne sampler but was manually placed in the water. A second difference in this sampler was that its triggering action could be fired at a predetermined time by the use of an electric timer that would close a pair of contact points.

The trigger action of this buoy was quite different from previous designs. The spring clip was of the same design, but a new method of releasing the spring clip was used. A small photographic flashbulb was placed between the leaves of the spring, and a 1-mil polyethylene strip, about 15 cm long and 1.5 cm wide, was wound around the spring leaves and the flashbulb. Figure 9 shows the trigger in more detail. When the flashbulb is fired, the heat of the flashbulb melts the polyethylene, thereby releasing the spring and allowing the sample water to flow through the intake hose. Figure 10 is a schematic drawing of the trigger circuit.

The time buoy was used in the field and the effectiveness was calculated to be about 60%. The low effectiveness was attributed to a high up center of buoyancy and not enough heat from one flashbulb to start the trigger action. Also the timer used on this sampler proved to be erratic in its function as a time measuring device. A more reliable timer is necessary.

THE POLYETHYLENE CARBOY SAMPLER

A sampler that would collect a large amount of surface water was necessary to satisfy the volume of water needed for certain biological tests. The sampler was to be airborne but it was not necessary to slow down its descent when dropped. A 5-gallon polyethylene carboy was modified for this sampler. Polyethylene had been used before as a material for a sampler and its properties were known. A piece of white oak, 18 x 15 x 2 cm, with a 9-cm-diameter hole cut out of the center was fitted on the neck of the carboy. The top of the cap and part of the neck were cut off, leaving the neck open with a 2-1/2 cm rim around it. The rim was tightened down to the oak board to keep the board from rotating (Fig. 11). When the sampler was dropped into the water the oak board had just enough buoyancy to keep the opening of the carboy half under the water surface (Fig. 12). Two 1/2-cm holes were just under the ends of the carboy handles. The hole on the underwater side allowed enough water to enter the carboy at the hole level so that the carboy, as it was filling pivoted along the length axis of the board parallel to the water surface. It was important to pivot the carboy in this manner because a maximum proportion of surface water would enter the carboy under this condition.

The effectiveness of the carboy sampler proved to be 98%. This sampler was very useful under all types of ocean conditions.

ACKNOWLEDGMENT

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SUMMARY TABLE

NAME	Sampler Characteristic	Volume Collected Milliliters	Per Cent Effectiveness
Polyethylene Sampler	1- liter wash bottle, flexible sides	100 to 200	72%
Filtering Flask Sampler	1-liter filter flask with partial vacuum	800 to 900	75%
Cookie-Cutter Sampler	1-liter Thermos bottle with surface-water capture	600 to 700	60%
Dewar Sampler	1-liter Dewar bottle quick descent, rapid intake	600 to 700	95%
Timer Buoy Sampler	2-liter surface and sub-surface intake	1700 to 1900	60%
Polyethylene Carboy Sampler	20-liter ocean micro-organism collector	19000 to 20000	98%

Table 1
Collection Properties of Polyethylene
Wash Bottle Samplers

Volume of Bottle (ml)	Time to Compress Bottle (sec)	Restoration Time with Air Intake (sec)	Restoration Time with Water Intake (sec)	Amount of Water Collected (ml)	Partial Restoration Time with Air Intake (sec)	Remaining Restoration Time with Water Intake (sec)	Amount of Water Collected (ml)
120	1	4	55	70	1	14	22
240	3	13	288	150	4	50	36
550	12	20	441	120	7	108	37
1000	13	32.5	780	552	10	276	162

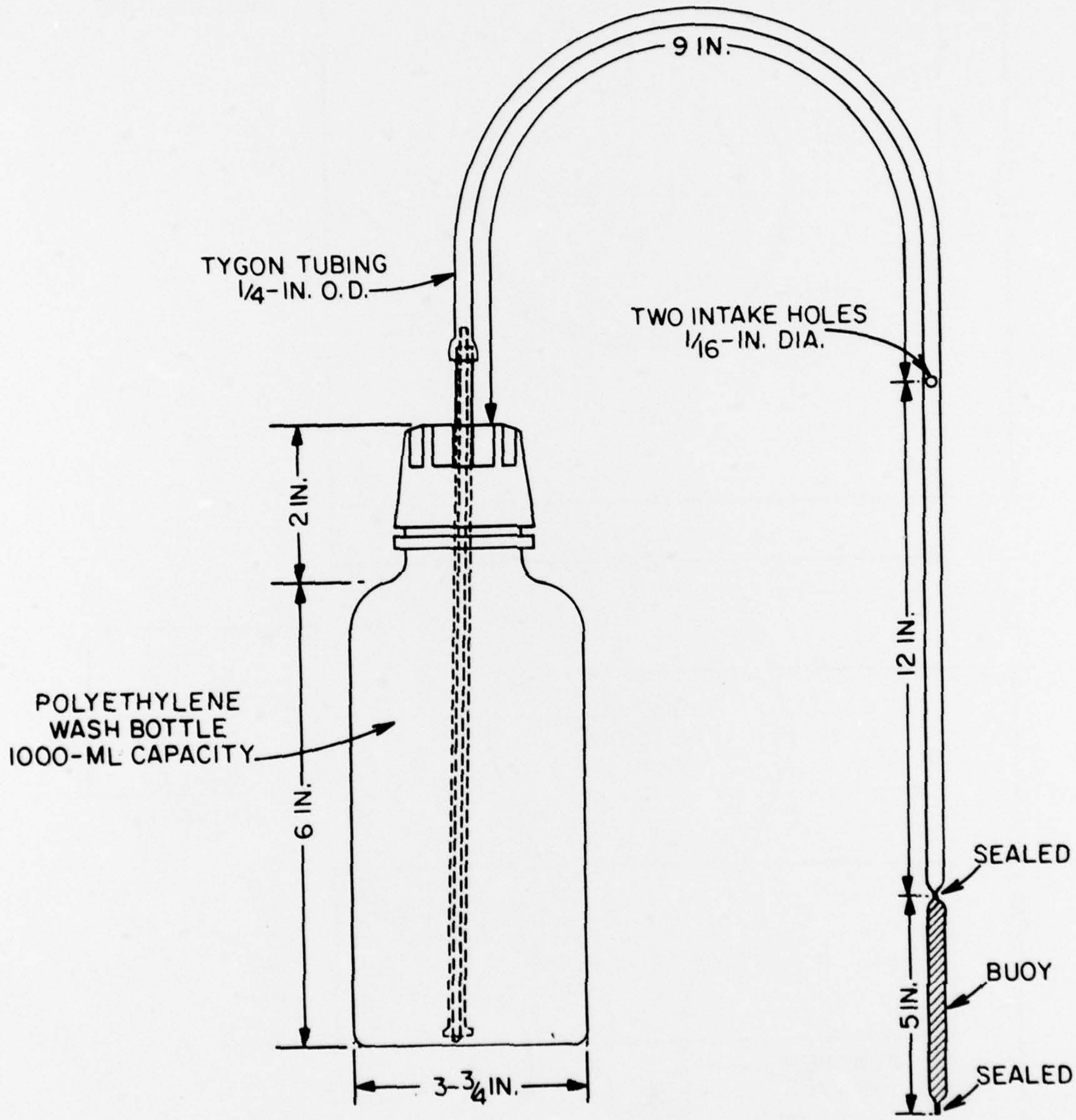

Fig. 1 - Polyethylene ocean-water sampler

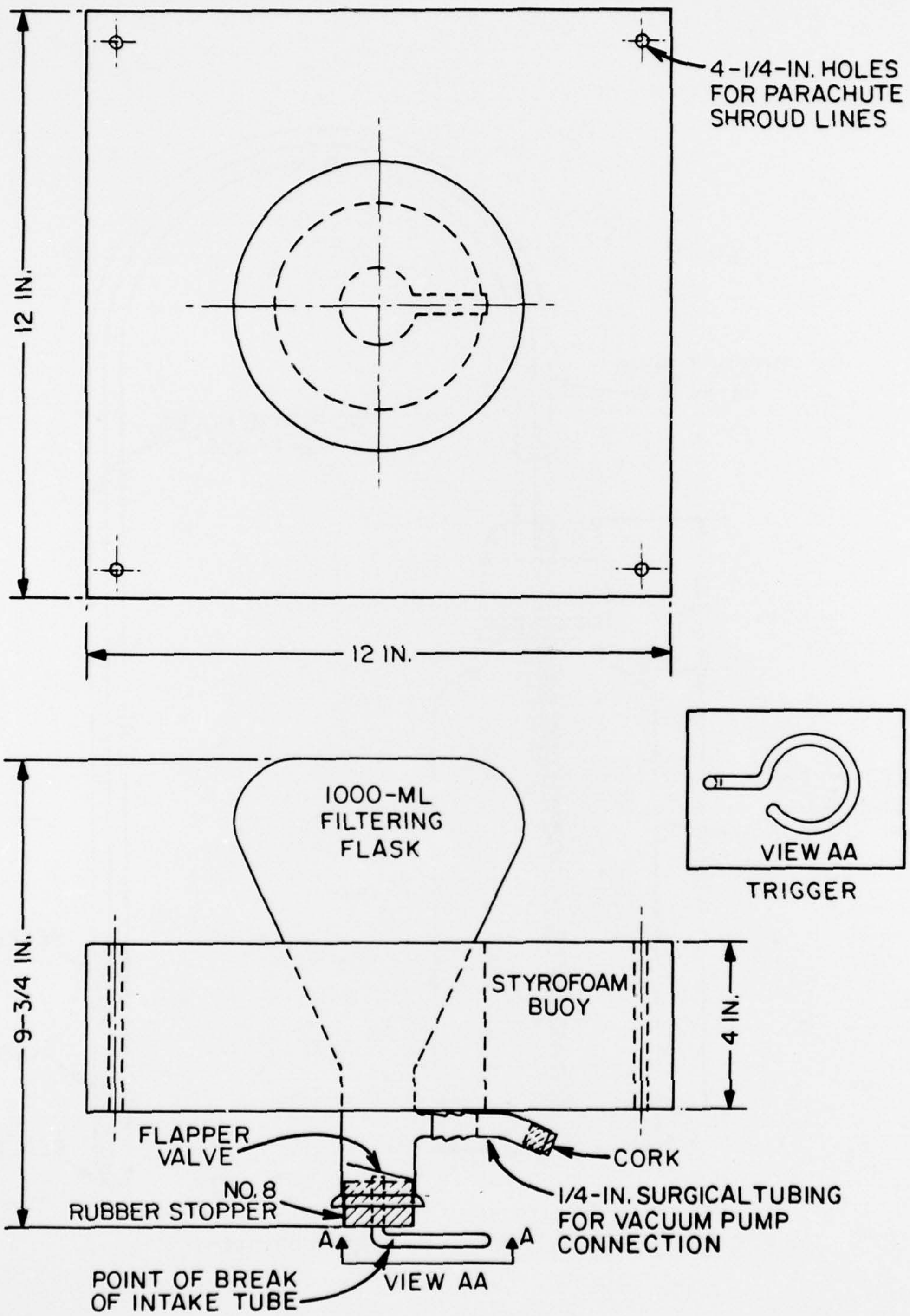

Fig. 2 - Design A of the filtering flask type sampler

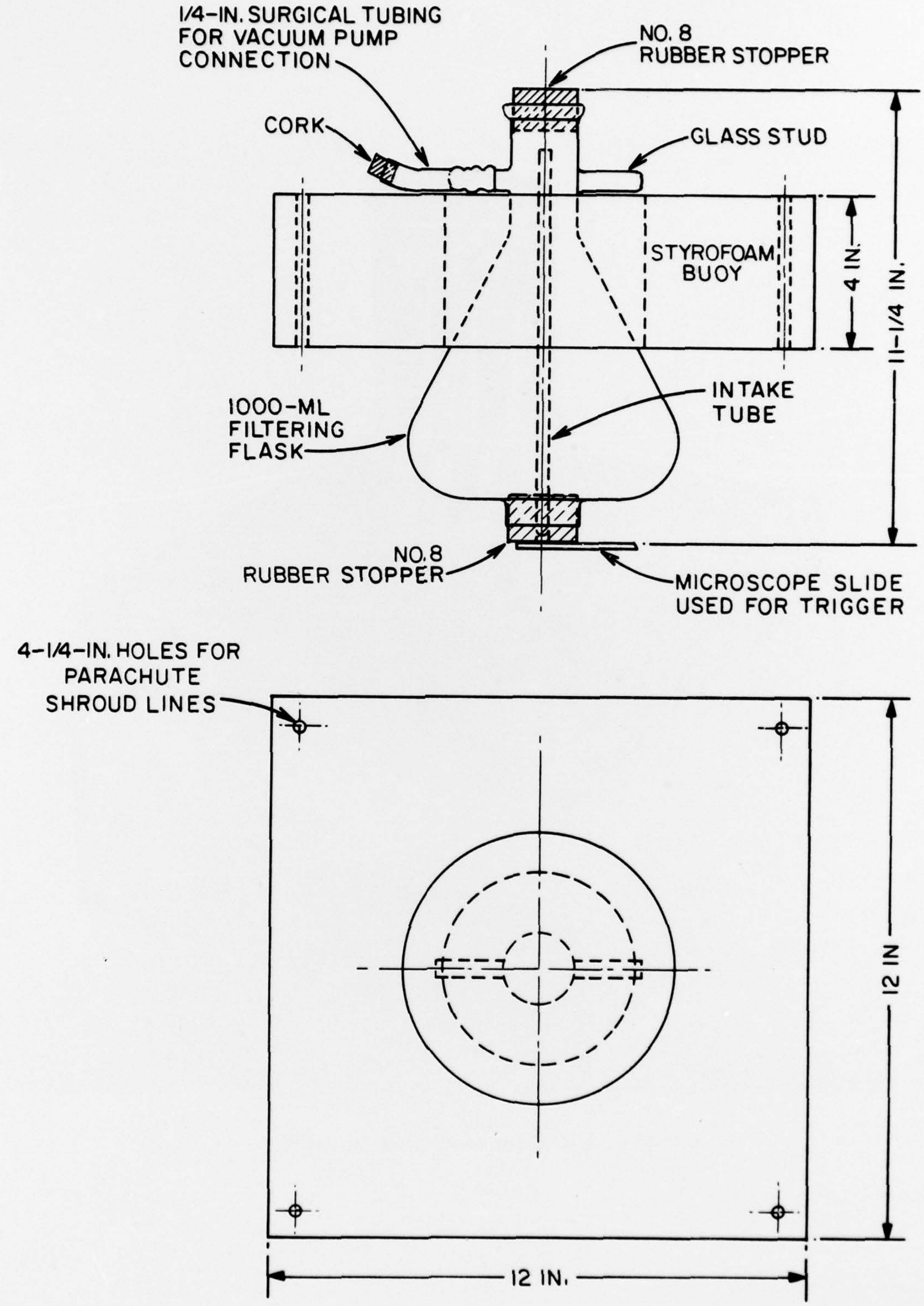

Fig. 3 - Design B of the filtering flask type sampler

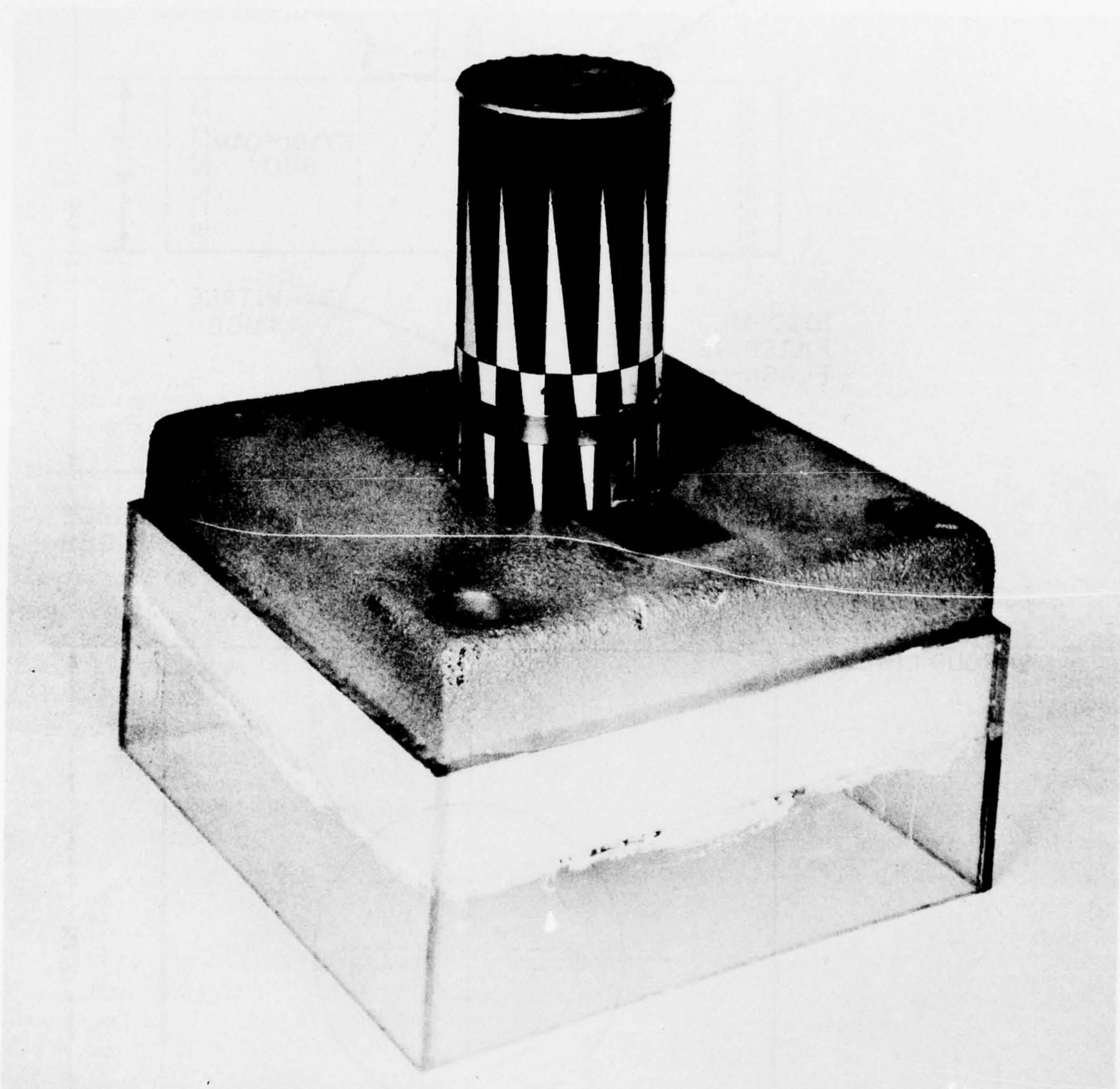

Fig. 4 - Cookie-cutter sampler

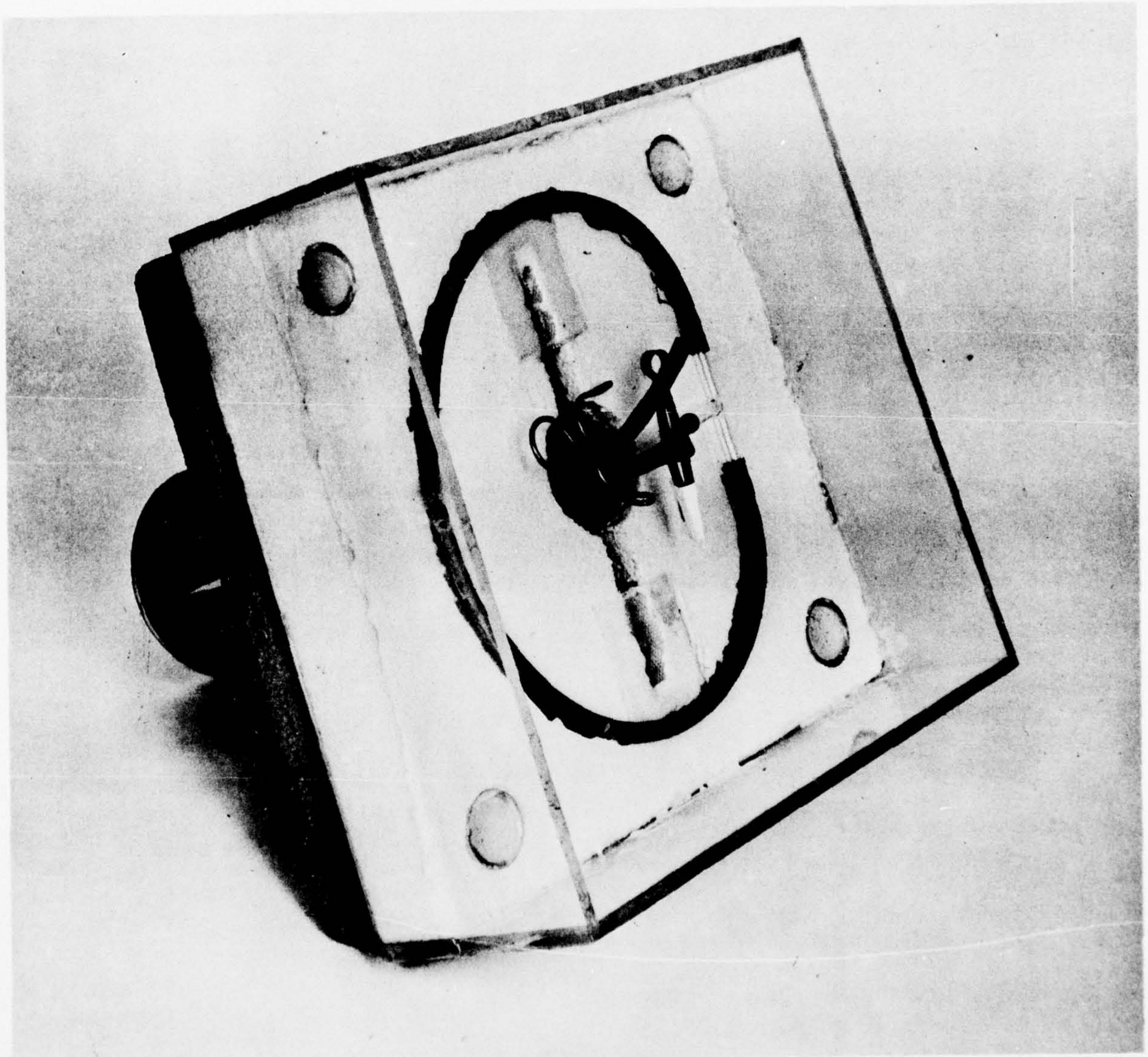

Fig. 5 - Bottom view of the cookie-cutter sampler

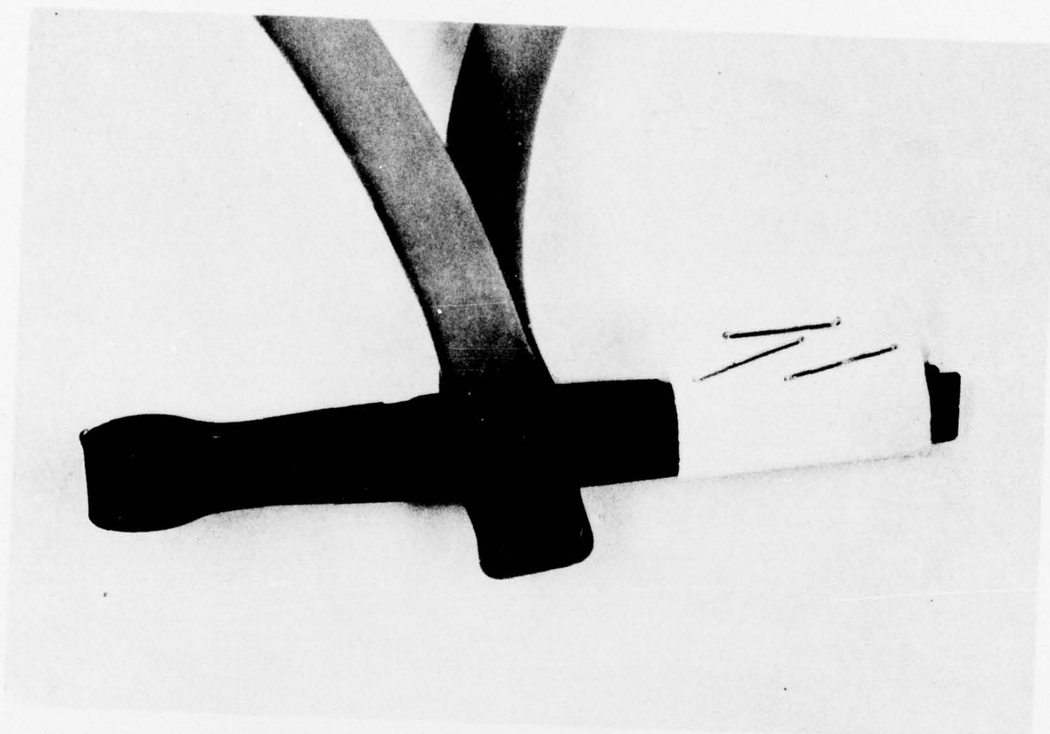

Fig. 6 - Clip to be released upon wetting of the paper band

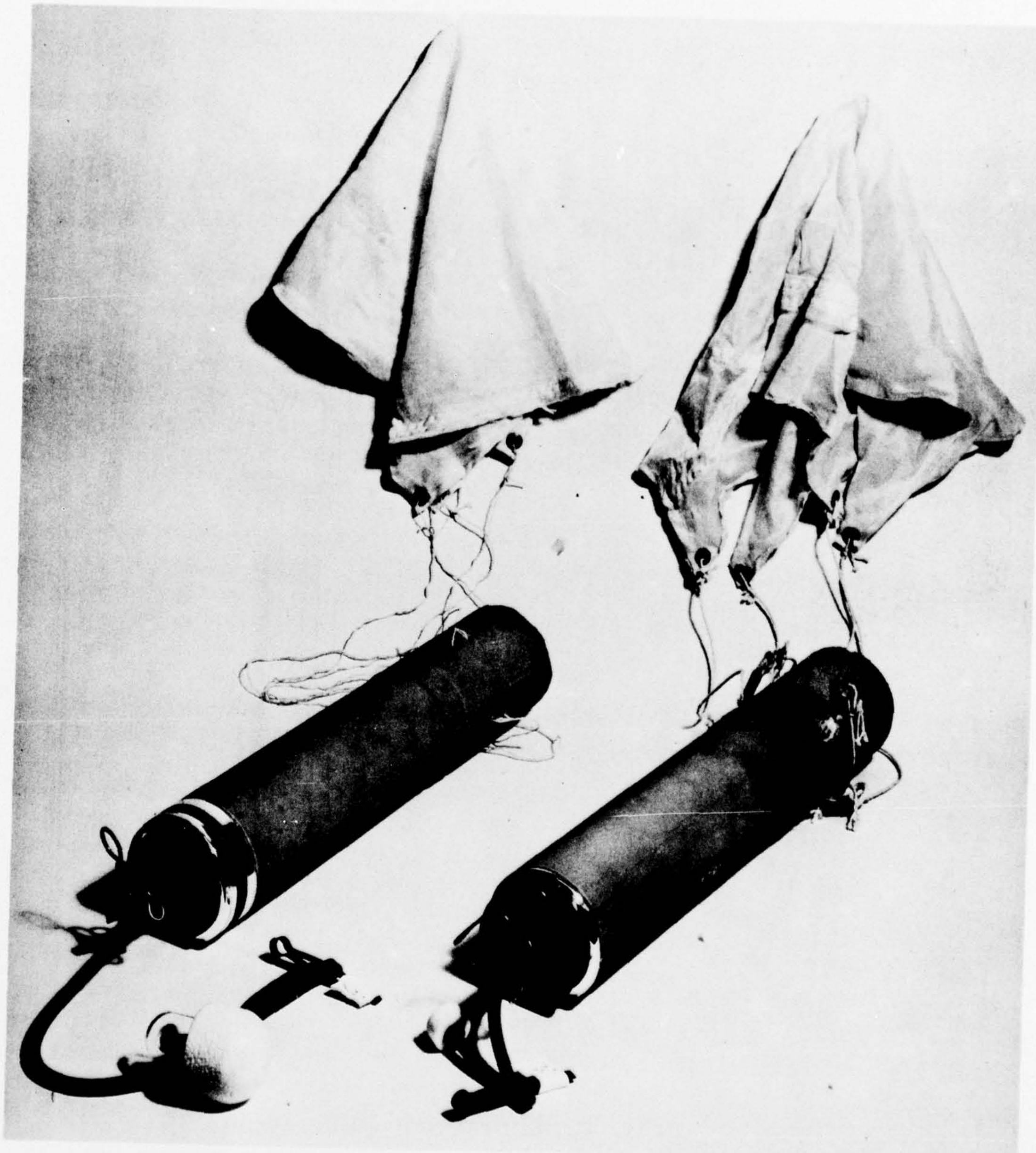

Fig. 7 - Dewar samplers

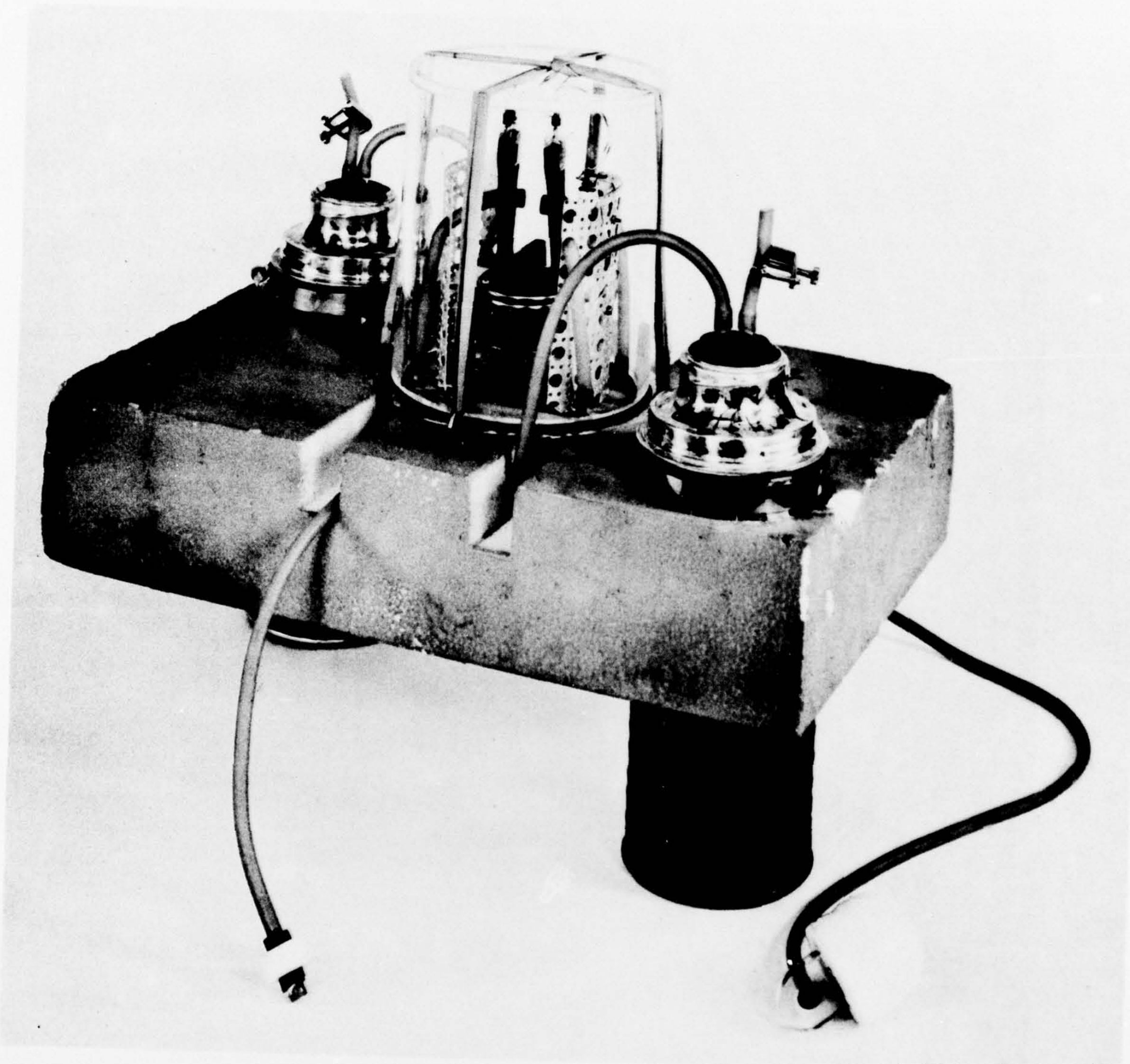

Fig. 8 - Timer buoy sampler

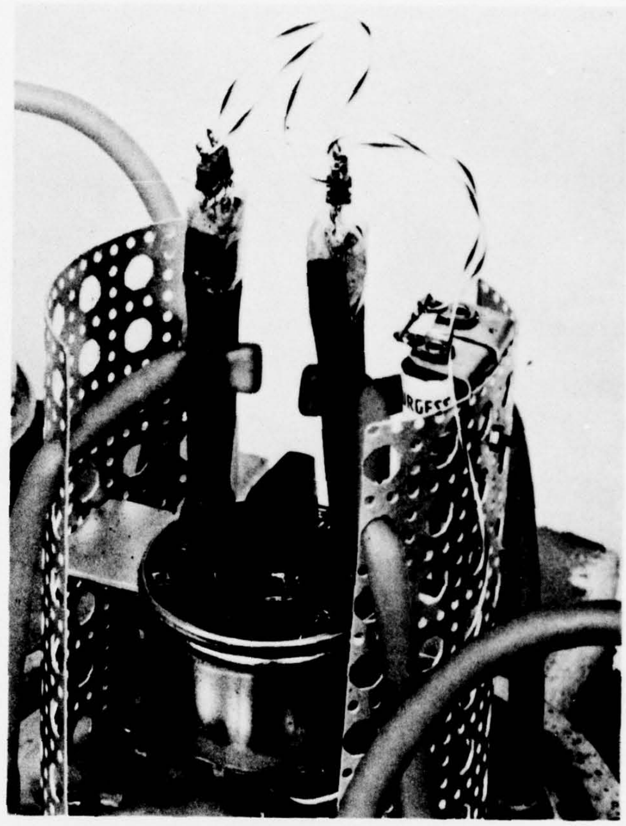

Fig. 9 - Trigger on the timer buoy sampler

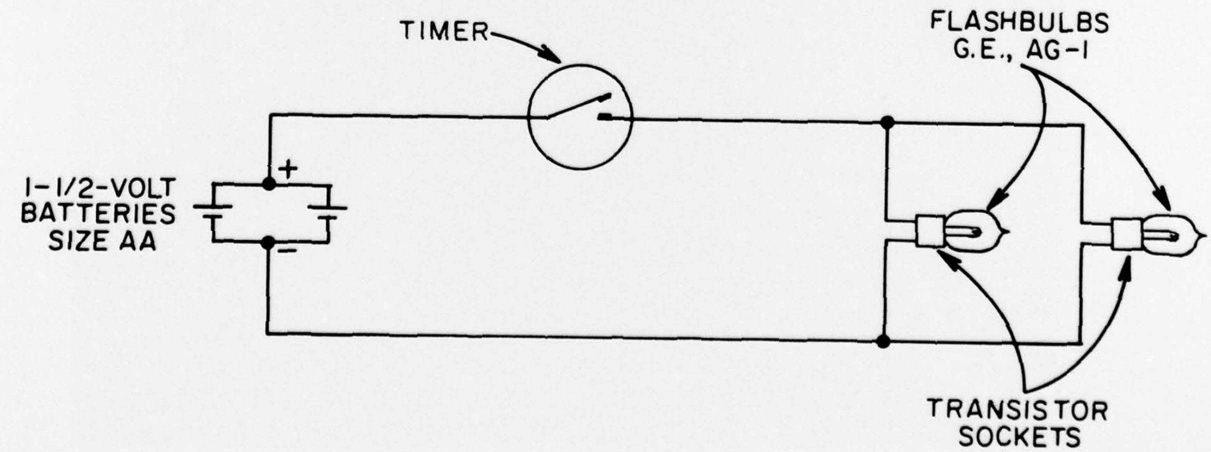

Fig. 10 - Trigger circuit on the timer buoy sampler

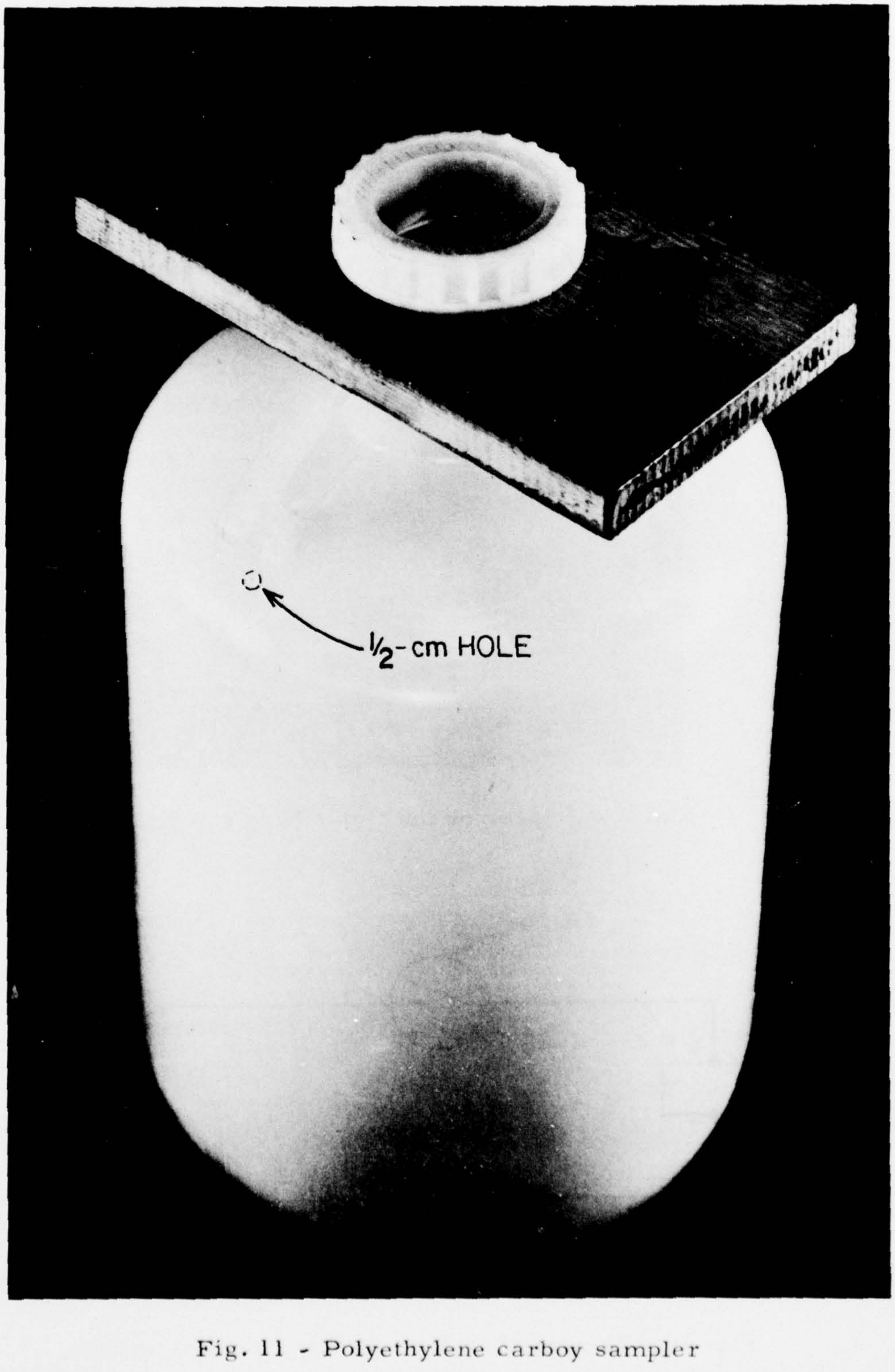

Fig. 11 - Polyethylene carboy sampler

Fig. 12 - Polyethylene carboy sampler while filling with water